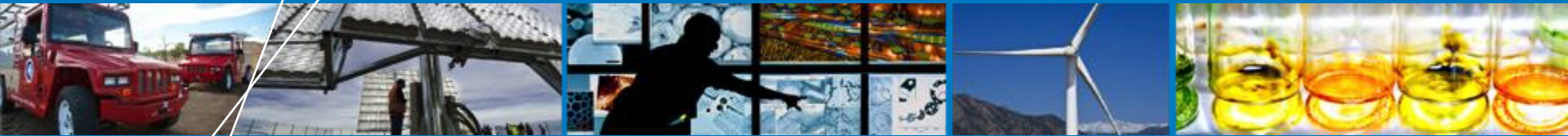


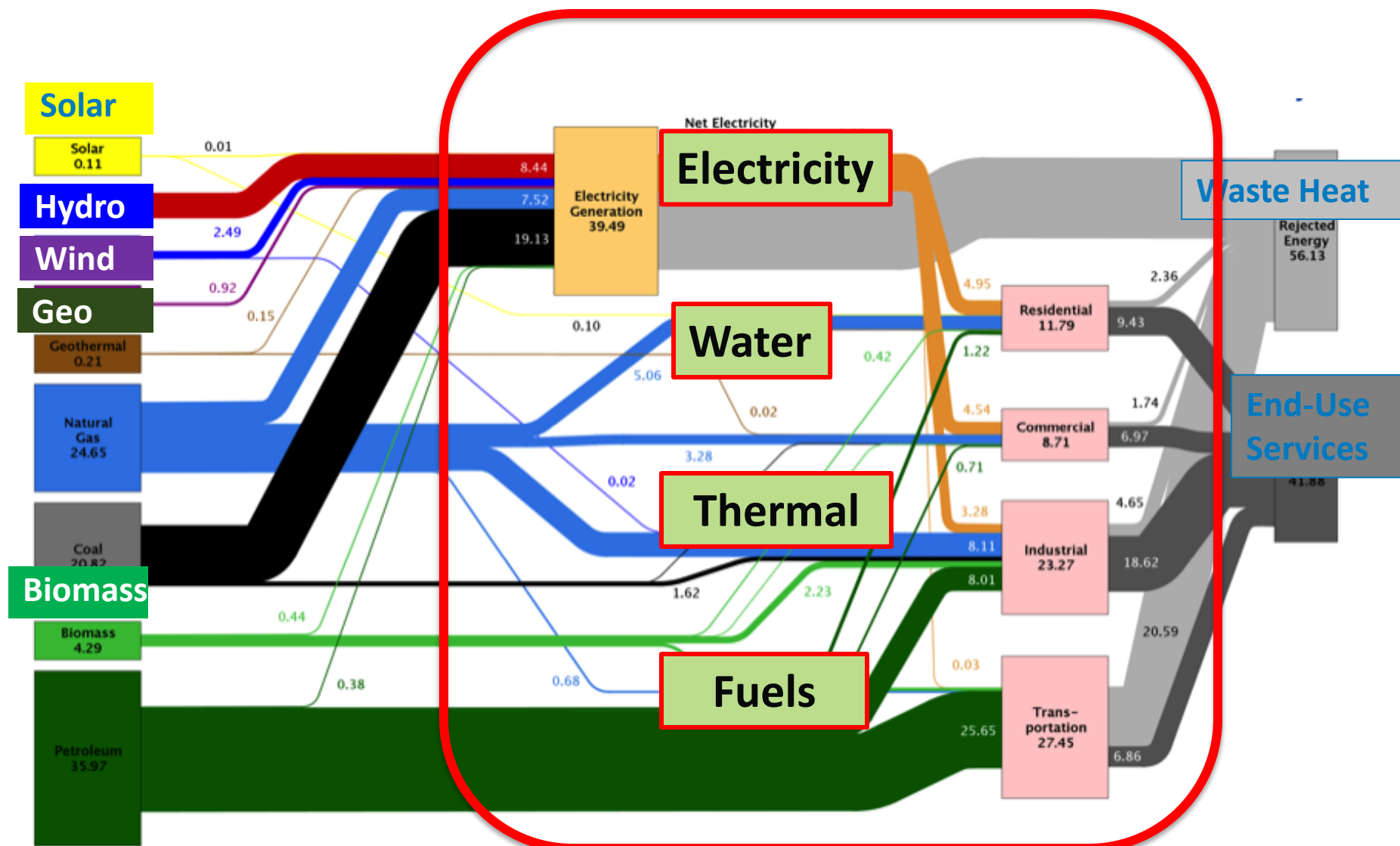
Energy Systems Integration



Dr. Martha Symko-Davies
Director of Partnerships-ESI

October 2015

Today's U.S. Energy System



Source: LLNL 2011. Data is based on DOE/EIA-0384(2010), October 2011. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for hydro, wind, solar and geothermal in RTU-equivalent values by assuming a typical fossil fuel plant "heat rate." (see EIA report for explanation of change to geothermal in 2010).

New Approach → Energy Systems Integration

Energy system integration (ESI) = the process of optimizing energy systems across multiple pathways and scales



Energy Systems Integration Facility (ESIF)

- NREL's largest R&D facility (182,500 ft²/20,000 m²)
- Space for 200 NREL staff and research partners
- 15 state-of-the-art hardware laboratories
- Integrated megawatt-scale electrical, thermal and fuel infrastructure
- High performance computation and data analysis capabilities
- 2-D/3-D advanced visualization



<http://www.nrel.gov/esi/esif.html>

ESIF Integrated Laboratories

Rooftop PV & Wind



Energy Storage Lab
Residential, Community
& Grid Battery Storage,
Flywheels & Thermal

Smart Power Lab
Buildings & Loads



**Energy Systems
Integration Lab**
Fuel Cells, Electrolyzers

Outdoor Test Area

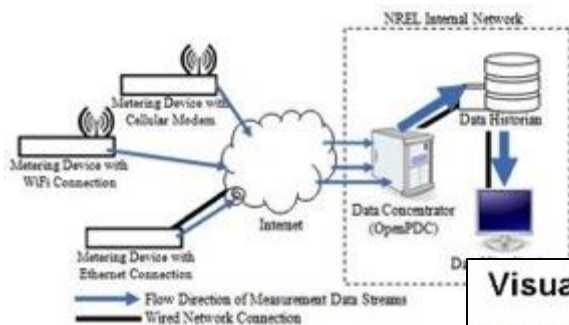
Outdoor Test Area
EVs, Power Transformers



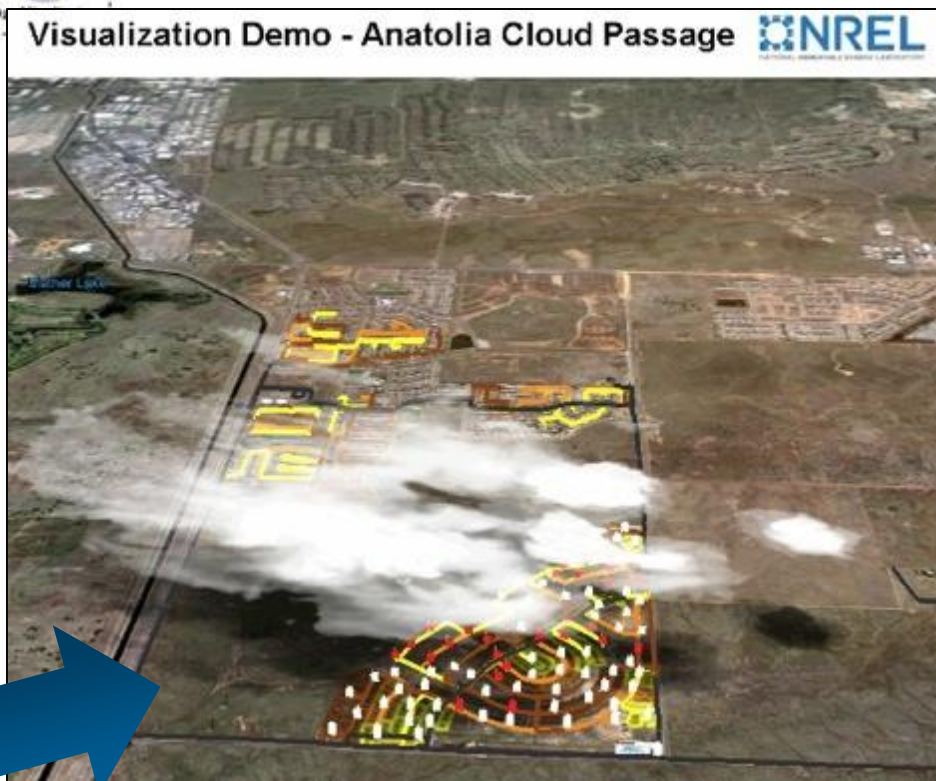
**Power Systems
Integration Lab**
PV Simulator



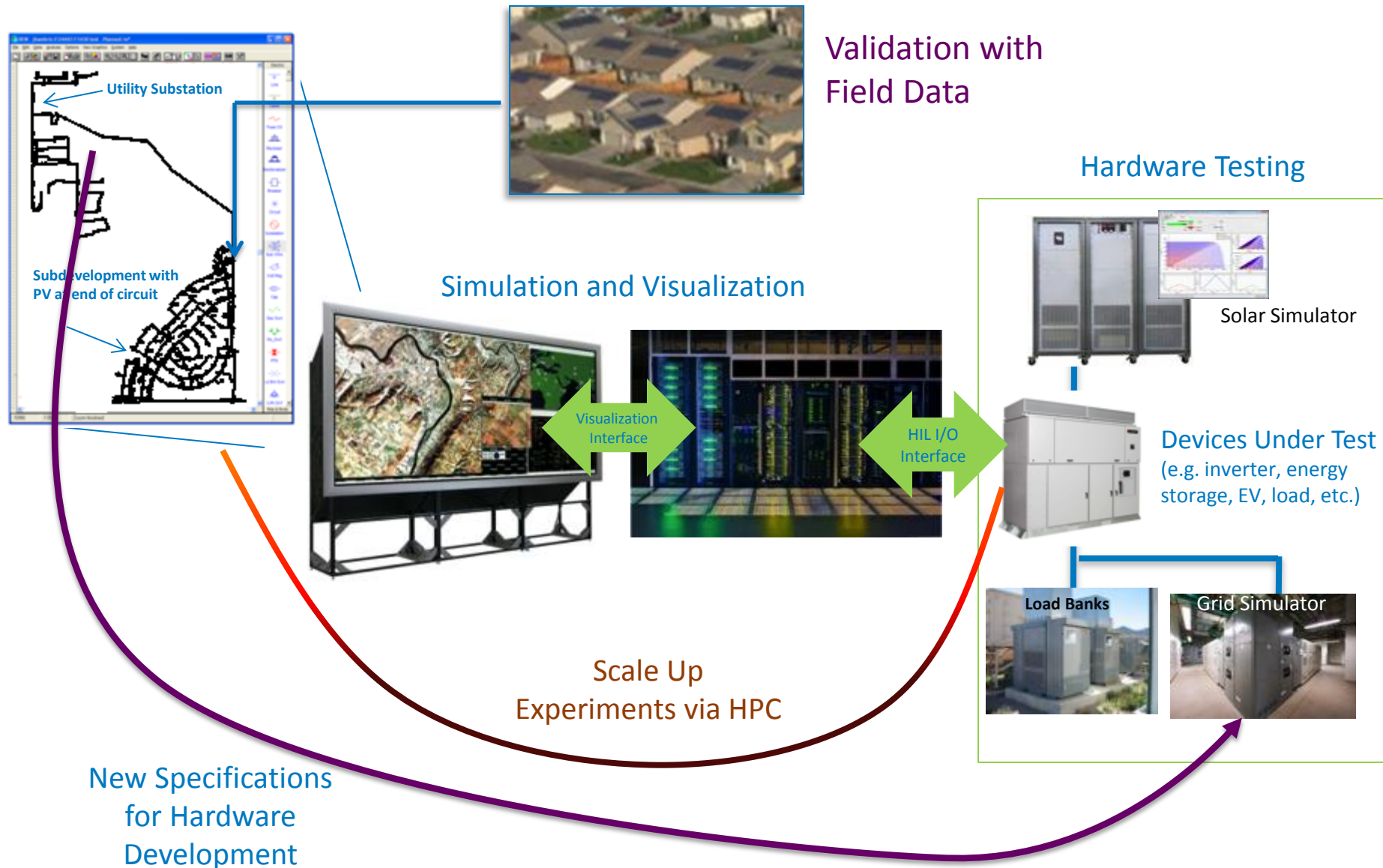
What types of problems are we solving?



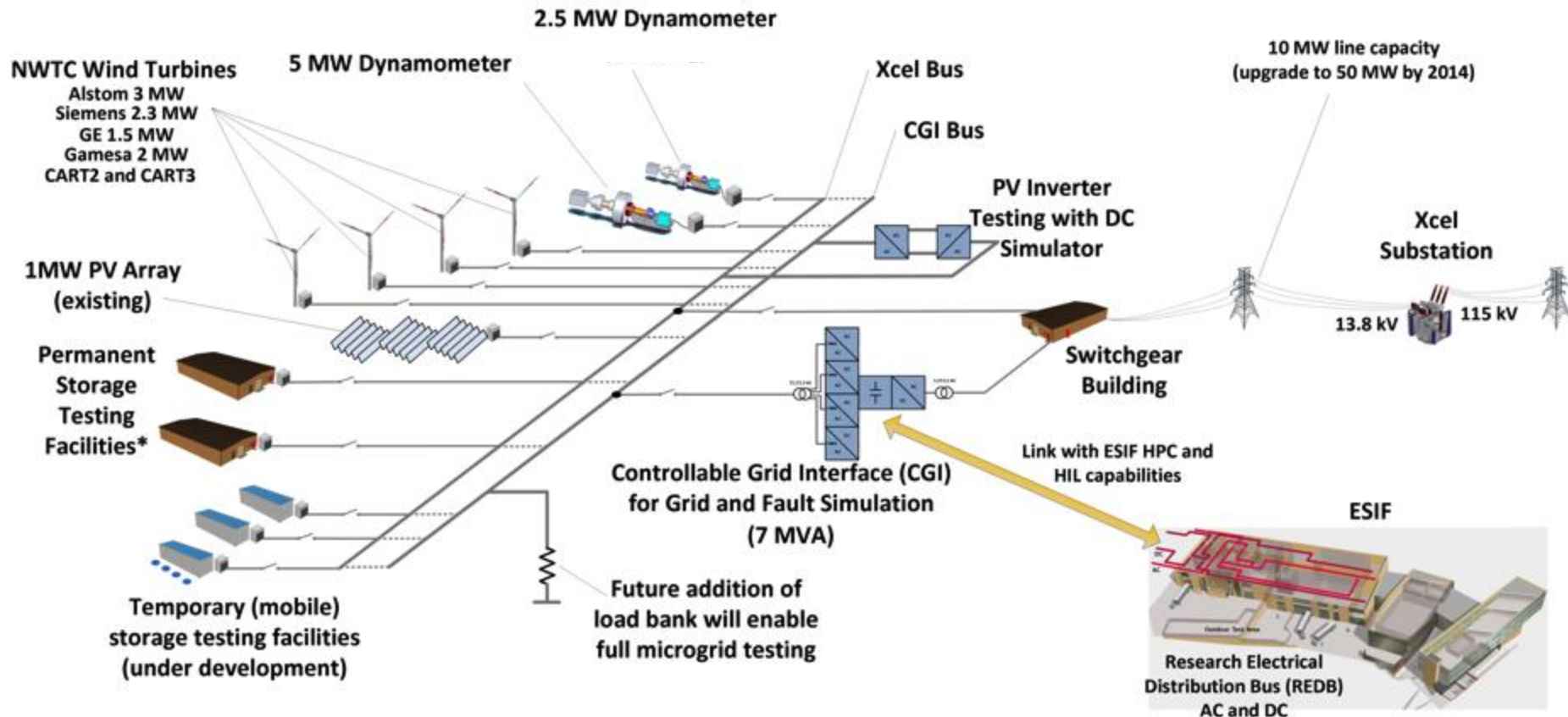
Understand and solving issues with high penetrations of variable renewables, distributed generation, electric vehicles, and controllable loads.



ESIF Hardware-in-the-Loop Capability



ESIF Linkage to NREL NWTC



*Permanent storage facility concept is under evaluation

Enables joint experiments involving both transmission and distribution system elements

External Partnership Highlights



Energy Systems Integration

- + Google
- + Advanced Energy
- + Toyota
- + Wyle
- + SolarCity and HECO
- + San Diego Gas & Electric
- + Southern California Gas
- + CSIRO
- + Duke and Alstom
- + Solectria
- + EPRI
- + Houze
- + American Vanadium
- + SunPower
- + Abengoa Energy-3D
- + Raytheon

For More Information

Martha Symko-Davies

Director of Partnerships, Energy Systems Integration

National Renewable Energy Laboratory

15013 Denver West Parkway

Golden, CO 80401 USA

+1-303-384-6528 (phone)

Martha.Symko.Davies@nrel.gov (email)

ESI ... Accelerating the Clean Energy Future